

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

**In re Patent Application for:**  
ADA Environmental Solutions, LLC

**Art Unit:** 3749

**First Named Inventor:** Johnson, et al.

**Examiner:** Rinehart, Kenneth

**Appln. No.:** 10/622,677

**Confirmation No.:** 3654

**Filing Date:** July 18, 2003

**Atty. Docket No.** 3791-13-CON

**For:** "LOW SULFUR COAL ADDITIVE FOR  
IMPROVED FURNACE OPERATION"

\* \* \*

**APPELLANTS' BRIEF**  
(37 CFR § 41.37)

MS Appeal Brief - Patents  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

Appellants hereby appeal to the Board of Appeals in response to the nonfinal Office Action mailed on August 15, 2008. A Notice of Appeal was filed on February 13, 2009. The fee set forth in 37 CFR § 41.20(b) has been previously submitted in connection with the Notice of Appeal. Although Appellants believe that no additional fees are due at this time, authorization to charge any necessary fees to Deposit Account No. 19-1970 is hereby given.

A single copy of this Appeal Brief is being submitted pursuant to MPEP §1205.02.

**(i) REAL PARTY IN INTEREST.**

All right, title, and interest in this application has been assigned by the inventors, Stephen Allen Johnson, John Wurster, and John Philip Comer to ADA Environmental Solutions, LLC. This Assignment is recorded at Reel/Frame 014682/0603.

**(ii) RELATED APPEALS AND INTERFERENCES.**

There are no related appeals, interferences or judicial proceedings known to Appellant, or the Appellant's legal representative which may be related to, directly affect, be directly affected by, or have a bearing on the Board's decision in the pending appeal.

**(iii) STATUS OF CLAIMS.**

Claims 24-26, 33-34, 36, 44-66, 68-88, 90-110, 112-132, 134-137, and 139-141 are currently pending. Claims 1-23, 27-32, 35, 37-43, 67, 89, 111, 133, 138, and 142 have been canceled. Accordingly, claims 24-26, 33-34, 36, 44-66, 68-88, 90-110, 112-132, 134-137, and 139-141 are being appealed.

Claims 24-26, 33-34, 36, 44-66, 73, 78-81, 87-88, 95, 100-102, 109-110, 122-124, 131-132, and 140-141 stand rejected under 35 U.S.C. §112, first paragraph.

Claims 24-26, 33-34, 36, 44-53, 55, 56, 61-66, 68-74, 76-77, 82-88, 90-96, 98-99, 104-110, 112-118, 120-121, 126-132, 134-137, and 139-141 stand rejected under 35 U.S.C. §103(a).

The Claims at issue (*i.e.*, Claims 104-145) are set forth in the CLAIMS APPENDIX.

**(iv) STATUS OF AMENDMENTS.**

All amendments made by Applicants have been entered by the Examiner. The most recent amendments made on October 27, 2008, in response to a non-final Office Action mailed on June 26, 2008, were entered and considered by the Examiner in the final Office Action dated November 17, 2008.

**(v) SUMMARY OF CLAIMED SUBJECT MATTER.**

The currently pending Independent Claims 24-26, 33-34, 36, 44-66, 68-88, 90-110, 112-132, 134-137, and 139-141 recited in the Claims Appendix hereto, are directed to methods to operate a solid fuel fired boiler (*See* Specification page 1, lines 18-25; Figure 1; page 1, line 24 through page 2, line 19; page 6, lines 6-19; Figure 9; page 14, line 1; page 18, line 10).

The invention addresses a problem that arises when a low sulfur (western) coal is combusted in a wet-bottom or slag-type furnace of the type shown in Fig. 1 (Specification pages 1, line 18, to page 3, line 8, and Figure 1). Such furnaces are designed for high sulfur (eastern) coals, which are disfavored due to sulfur oxide emissions. When low sulfur coals, with low iron and high alkali contents are combusted, the viscosity of the resulting slag is too low, causing less retained bottom ash (or a higher amount of entrained coal and ash particulates in the off gas from combustion) and therefore a higher incidence of stack opacity violations and increased fuel and maintenance costs, less reliable slag tapping, the occurrence of flames in the main furnace, high furnace exit temperatures, and increased convective pass fouling (Specification page 3, lines 10-17). To overcome these problems, the claimed method adds an iron-containing additive, particularly mill scale from steel production and dust from blast furnace gas cleaning equipment. The iron-containing additive acts as a fluxing agent to decrease the ash melting temperature and induce crystal formation in the melt, which effectively provides a higher viscosity slag in the furnace (Specification at pages 6, line 19, to page 7, line 22).

One embodiment, which is the subject of Independent Claim 24, is directed to a method comprising:

(a) introducing a solid fuel into the boiler (item 100), wherein the solid fuel is a coal having a sulfur content of less than about 1.5 wt.% (dry basis of the coal) (Specification page 1, lines 18-25; Figure 1; page 1, line 24 through page 2, line 19; page 6, lines 6-19; page 18, line 10; Figure 9; page 14, line 1; page 18, line 10);

(b) introducing an iron-containing material into the boiler, wherein the iron-containing material is at least one of mill scale from steel production and dust from blast furnace gas cleaning equipment (Specification page 5, line 18 through page 6, line 4; page 6, line 19 through page 7, line 14; page 11, line 8 through page 12, line 19; Figure 9; page 14, line 1; page 18, line 10); and

(c) at least partially combusting the solid fuel to produce an ash slag, wherein, in the at least partially combusting step (Specification page 2, lines 14-15; page 6, lines 4-5 and 15-18; Figures 1, 4-5, 7-8 and page 20, lines 1-21; Figure 9; page 14, line 1; page 18, line 10), at least one of the following is true:

(i) the ash slag has a fluid temperature less than a fluid temperature characteristic of the ash slag produced from combustion of the solid fuel alone (Specification page 19, lines 5-10; page 5, lines 13-17; page 6, lines 19-22; page 7, lines 15-22; page 8, lines 9-10; page 9, lines 14-15; page 20, lines 1-22; Figures 7-8; Figure 9; page 14, line 1; page 18, line 10); and

(ii) the ash slag has a melting point less than the melting point of a second ash slag produced from the combustion of the solid fuel alone (Specification page 19, lines 5-10; page 5, lines 13-17; page 6, lines 19-22; page 7, lines 15-22; page 8, lines 9-10; page 9, lines 14-15; page 20, lines 1-22; Figures 7-8; Figure 9; page 14, line 1; page 18, line 10).

One embodiment, which is the subject of Independent Claim 68, is directed to a method of operating a solid fuel fired boiler comprising:

(a) introducing a solid fuel into a wet-bottom boiler (item 100), wherein the solid fuel is a low sulfur coal having a sulfur content of less than about 1.5 wt.% (dry basis of the coal) (Specification page 1, lines 18-25; Figure 1; page 1, line 24 through page 2, line 19; page 6, lines 6-19; Figure 9; page 14, line 1; page 18, line 10);

(b) introducing an iron-containing material into the wet-bottom boiler, wherein the iron-containing material is at least one of mill scale from steel production and dust from blast furnace gas cleaning equipment (Specification page 5, line 18 through page 6, line 4; page 6, line 19 through page 7, line 14; page 11, line 8 through page 12, line 19; Figure 9; page 14, line 1; page 18, line 10); and

(c) at least partially combusting the solid fuel to produce an ash slag, wherein at least a portion of the iron-containing material fluxes the ash slag to cause the ash slag to have a melting temperature less than the melting temperature of a second ash slag produced from the combustion of the solid fuel alone (Specification page 19, lines 5-10; page 5, lines 13-17; page 6, lines 19-22; page 7, lines 15-22; page 8, lines 9-10; page 9, lines 14-15; page 20, lines 1-22; Figures 7-8; Figure 9; page 14, line 1; page 18, line 10)

One embodiment, which is the subject of Independent Claim 90, is directed to a method of operating a solid fuel fired boiler comprising:

(a) introducing a solid fuel into a wet-bottom boiler (item 100), the solid fuel comprising a low sulfur coal having a sulfur content of less than about 1.5 wt.% (dry basis of the coal) (Specification page 1, lines 18-25; Figure 1; page 1, line 24 through page 2, line 19; page 6, lines 6-19; Figure 9; page 14, line 1; page 18, line 10);

(b) introducing an iron-containing material into the wet-bottom boiler, wherein the iron-containing material is at least one of mill scale from steel production and dust from blast furnace gas cleaning equipment (Specification page 5, line 18 through page 6, line 4; page 6, line 19 through page 7, line 14; page 11, line 8 through page 12, line 19; Figure 9; page 14, line 1; page 18, line 10); and

(c) at least partially combusting the solid fuel to produce an ash slag, wherein at least a portion of the iron-containing material fluxes the ash slag to cause the ash slag to have a

viscosity in the boiler less than the viscosity in the boiler of a second ash slag produced from the combustion of the solid fuel alone (Specification page 19, lines 5-10; page 5, lines 13-17; page 6, lines 19-22; page 7, lines 15-22; page 8, lines 9-10; page 20, lines 1-22; Figure 9; page 14, line 1; page 18, line 10; page 2, lines 17-19; page 9, lines 13-19; Figures 3 and 7-8; page 15, lines 5-10; page 18, line 12 through page 19, line 10; page 20, lines 1-20).

One embodiment, which is the subject of Independent Claim 112, is directed to a method of operating a solid fuel fired boiler comprising:

(a) introducing a solid fuel into a wet-bottom boiler, the solid fuel comprising a low sulfur coal having a sulfur content of less than about 1.5 wt.% (dry basis of the coal) (Specification page 1, lines 18-25; Figure 1; page 1, line 24 through page 2, line 19; page 6, lines 6-19; Figure 9; page 14, line 1; page 18, line 10);

(b) introducing an iron-containing material into the wet-bottom boiler, wherein the iron-containing material comprises iron oxides (Specification page 12, lines 7-19; page 4, lines 12-13; page 6, lines 20-22; page 7, lines 1-14; page 11, lines 11-20; Figure 9; page 14, line 1; page 18, line 10); and

(c) at least partially combusting the solid fuel to produce an ash slag, wherein at least a portion of the iron-containing material fluxes the ash slag to cause the ash slag to have a viscosity less than a viscosity of a second ash slag produced from the combustion of the solid fuel alone (Specification page 19, lines 5-10; page 5, lines 13-17; page 6, lines 19-22; page 7, lines 15-22; page 8, lines 9-10; page 20, lines 1-22; Figure 9; page 14, line 1; page 18, line 10; page 2, lines 17-19; page 9, lines 13-19; Figures 3 and 7-8; page 15, lines 5-10; page 18, line 12 through page 19, line 10; page 20, lines 1-20).

One embodiment, which is the subject of Independent Claim 134 is directed to a method for operating a slag type furnace comprising:

(a) introducing a coal-containing fuel into said slag type furnace, the coal-containing fuel comprising a low sulfur coal having a sulfur content of less than about 1.5 wt.% (dry basis of the coal) (Specification page 1, lines 18-25; Figure 1; page 1, line 24 through page 2, line 19; page 6, lines 6-19; Figure 9; page 14, line 1; page 18, line 10);

(b) introducing an iron-containing additive into the slag type furnace in an amount sufficient to flux the coal-containing fuel (Specification page 19, lines 5-10; page 5, lines 13-17; page 6, lines 19-22; page 7, lines 15-22; page 8, lines 9-10; page 9, lines 14-15; page 20, lines 1-22; Figures 7-8; Figure 9; page 14, line 1; page 18, line 10); and

(c) melting at least a portion of the coal-containing fuel to produce an ash slag, wherein, in the melting step, at least a portion of the iron-containing additive fluxes the ash

slag to produce a slag layer having a melting point less than a melting point of a second slag layer without the iron-containing additive (Specification page 19, lines 5-10; page 5, lines 13-17; page 6, lines 19-22; page 7, lines 15-22; page 8, lines 9-10; page 9, lines 14-15; page 20, lines 1-22; Figures 7-8; Figure 9; page 14, line 1; page 18, line 10).

Dependent claim 25 requires the ash slag to have a viscosity during the at least partially combusting step that is less than the viscosity of the second ash slag produced from combustion of the solid fuel alone (Specification page 19, lines 5-10; page 5, lines 13-17; page 6, lines 19-22; page 7, lines 15-22; page 8, lines 9-10; page 20, lines 1-22; Figure 9; page 14, line 1; page 18, line 10; page 2, lines 17-19; page 9, lines 13-19; Figures 3 and 7-8; page 15, lines 5-10; page 18, line 12 through page 19, line 10; page 20, lines 1-20). *See* claims 51, 72, 85, 94 and 116.

Dependent claim 26 requires the ash slag to have a melting point during the at least partially combusting step that is less than the melting point of the second ash slag produced from combustion of the solid fuel alone (Specification page 19, lines 5-10; page 5, lines 13-17; page 6, lines 19-22; page 7, lines 15-22; page 8, lines 9-10; page 9, lines 14-15; page 20, lines 1-22; Figures 7-8; Figure 9; page 14, line 1; page 18, line 10). *See* claims 87, 107, 109, 129, and 131.

Dependent claim 33 requires at least a portion of the iron-containing material to flux the ash slag to produce a second ash slag having at least one characteristic selected from the group consisting of viscosity and melting temperature less than the same characteristic of the second ash slag produced from combustion of the solid fuel alone (Specification page 19, lines 5-10; page 5, lines 13-17; page 6, lines 19-22; page 7, lines 15-22; page 8, lines 9-10; page 20, lines 1-22; Figure 9; page 14, line 1; page 18, line 10; page 2, lines 17-19; page 9, lines 13-19; Figures 3 and 7-8; page 15, lines 5-10; page 18, line 12 through page 19, line 10; page 20, lines 1-20).

Dependent claim 34 requires a  $T_{250}$  temperature at which the ash slag has a viscosity of 250 poise produced from the combustion of the solid fuel and iron-containing material to be at least 100 degrees Fahrenheit lower than the  $T_{250}$  temperature of the second ash slag produced from the combustion of the solid fuel alone (Specification page 19, lines 5-10; page 5, lines 13-17; page 6, lines 19-22; page 7, lines 15-22; page 8, lines 9-10; page 20, lines 1-22; Figure 9; page 14, line 1; page 18, line 10; page 2, lines 17-19; page 9, lines 13-19; Figures 3 and 7-8; page 15, lines 5-10; page 18, line 12 through page 19, line 10; page 20, lines 1-20).

Dependent claim 36 requires the melting point of the second ash slag to be less than 2600 degrees F (Specification Figures 7-8; page 2 lines 14-17; page 20 lines 14-21; page 18, line 10). *See* claims 88, 110, and 132.

Dependent claim 45 requires the fluid temperature to be less than 2600 degrees F (Specification Figures 7-8; page 2 lines 14-17; page 20 lines 14-21; page 18, line 10).

Dependent claim 47 requires the solid fuel to be introduced into a wet-bottom boiler (Specification page 1, lines 18-25; Figure 1; page 1, line 24 through page 2, line 19; page 6, lines 6-19; Figure 9; page 14, line 1; page 18, line 10). *See* claims 140.

Dependent claim 48 requires the solid fuel to comprise a sub-bituminous coal and wherein the solid fuel has a low iron content and a high alkali content (Specification page 3, lines 1-12; page 6, lines 6-10; page 18, line 10). *See* claims 91 and 113.

Dependent claim 49 requires the boiler to be for at least one of steam production and electricity generation and wherein the iron-containing material has a P<sub>90</sub> size of no more than about 300 microns (Specification page 8, lines 1-3; page 12, lines 3-6; page 1, lines 18-19; page 12, lines 14-17; page 10, lines 1-3; page 18, line 10). *See* claims 70, 92, 114, 136, and 141.

Dependent claim 50 requires the boiler to be a cyclone boiler (Specification page 1, lines 18-25; Figure 1; page 1, line 24 through page 2, line 19; page 6, lines 6-19; Figure 9; page 14, line 1; page 18, line 10). *See* claim 71.

Dependent claim 52 further requires the step reducing the particle size of the solid fuel prior to introducing the solid fuel into the boiler. (Specification page 5, lines 4-10; Figure 1; Figure 9; page 14, line 1; page 18, line 10). *See* claims 73, 95, and 117.

Dependent claim 53 requires the iron-containing material to be mill scale from steel production. (Specification page 12, lines 7-19; page 18, line 10). *See* claims 74, 96, and 118.

Dependent claim 54 requires the iron-containing material to be dust from blast furnace gas cleaning equipment. (Specification page 12, lines 7-19; page 18, line 10). *See* claims 75, 97, and 119.

Dependent claim 55 requires the iron-containing material to comprise at least one of ferrous oxide and ferric iron oxide. (Specification page 12, lines 7-19; page 4, lines 12-13; page 6, lines 20-22; page 7, lines 1-14; page 11, lines 9-20; page 18, line 10). *See* claims 76, 98, and 120.

Dependent claim 56 requires the iron-containing material to comprise magnetite. (Specification page 7, lines 1-14; page 20, lines 1-3; page 18, line 10). *See* claims 77, 99, and 121.

Dependent claim 57 requires the iron-containing material to comprise at least one carbon compound. (Specification page 3, lines 6-8; page 4, lines 12-14; page 12, lines 13-19; page 13, lines 10-13; page 18, line 10). *See* claims 78, 100, and 122.

Dependent claim 58 requires the further step of introducing at least one carbon compound along with the iron-containing material, the at least one carbon compound being one or more of a hydrocarbon, oil, grease, and xanthan gum. (Specification page 3, lines 6-8; page 4, lines 12-14; page 12, lines 13-19; page 13, lines 10-13; page 18, line 10). *See* claims 79, 101, and 123.

Dependent claim 59 requires the boiler to comprise:  
a particle size reduction device, wherein the solid fuel is fed to the device;  
a burner;  
a fuel transfer system communicating with the device and the burner; and  
a combustion chamber comprising an enclosure at least partially surrounding the burner and the further step of:

introducing the iron-containing material into at least one of the fuel storage bunker, the fuel transfer system, the cyclone burner, and the combustion chamber. (Specification Figures 1, 4, 5; page 1, lines 24-28; page 2, lines 1-19; page 14, lines 1-22; page 15, lines 1-4; page 16, lines 4-22; page 17, lines 1-20; Figure 9; page 14, line 1; page 18, line 10). *See* claims 80, 102, and 124.

Dependent claim 60 requires the cyclone boiler to comprise:  
a fuel storage bunker (items 216 and 304);  
a cyclone burner (item 100);  
a fuel transfer system (items 232, 240, and 244a,b (Fig. 4) and items 308, 240, and 344a,b (Fig. 5)) communicating with the fuel storage bunker and the cyclone burner; and  
a combustion chamber comprising an enclosure at least partially surrounding the burners. (Figures 1, 4, 5; page 1, lines 24-28; page 2, lines 1-19; page 14, lines 1-22; page 15, lines 1-4; page 16, lines 4-22; page 17, lines 1-20; Figure 9; page 14, line 1; page 18, line 10). *See* claims 81, 103, and 125.

Dependent claim 61 requires the iron-containing material to be introduced into the boiler in an amount ranging from about 10 lb/ton of solid fuel to about 50 lb/ton of solid fuel. (Specification page 9, lines 6-7; page 18, line 10). *See* claims 82, 104, and 126.

Dependent claim 62 requires the ash slag to have a total iron concentration of at least about 15 weight percent. (Specification page 15, lines 5-8; page 18, line 10). *See* claims 83, 105, and 127.

Dependent claim 63 requires the iron-containing material to be added to the solid fuel before introducing the solid fuel and the iron-containing material into the boiler.

(Specification Figure 4; page 13 lines 19-22; page 14, lines 1-13; Figure 9; page 14, line 1; page 18, line 10).

Dependent claim 64 requires the ash slag to have a viscosity in the boiler less than the viscosity in the boiler of a second ash slag produced from the combustion of the solid fuel alone. (Specification page 19, lines 5-10; page 5, lines 13-17; page 6, lines 19-22; page 7, lines 15-22; page 8, lines 9-10; page 20, lines 1-22; Figure 9; page 14, line 1; page 18, line 10; page 2, lines 17-19; page 9, lines 13-19; Figures 3 and 7-8; page 15, lines 5-10; page 18, line 12 through page 19, line 10; page 20, lines 1-20).

Dependent claim 65 requires the iron-containing material to be selected from the group consisting of ferrous oxide, ferric oxide, ferrous sulfide, ferric sulfide, and combinations thereof.. (Specification page 12, lines 7-19; page 4, lines 12-13; page 6, lines 20-22; page 7, lines 1-14; page 11, lines 8-20; page 3, lines 6-8; page 18, line 10). *See* claims 86, 108, and 130.

Dependent claim 69 requires the solid fuel to comprise a sub-bituminous coal, wherein the coal has a total iron content of less than about 10 wt.% (dry basis of the ash), and wherein the coal has a calcium content of at least about 15 wt.% (dry basis of the ash). (Specification page 3, lines 1-12; page 6, lines 6-10; page 18, line 10). *See* claims 93, 115, and 139.

Dependent claim 135 requires at least about 33.5% of the iron-containing additive is in the form of ferrous iron and no more than about 66.5% of the iron in the additive is in the form of ferric iron. (Specification page 6, line 19, to page 7, line 14).

**(vi) GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL.**

Whether Claims 24-26, 33-34, 36, 44-66, 73, 78-81, 87-88, 95, 100-102, 109-110, 122-124, 131-132, and 140-141 comply with 35 U.S.C. §112, first paragraph..

Whether Claims 24-26, 33-34, 36, 44-66, 68-88, 90-110, 112-132, 134-137, and 139-141 are patentable under 35 U.S.C. §103(a) based on U.S. 1,955,574 to Benner in view of U.S. 4,572,085 to Hepworth and further in view of one or more of U.S. 4,886,521 to Khan, U.S. 3,896,746 to Pirsh, U.S. 4,089,507 to Arai, et al., and U.S. 5,046,265 to Kalb.

Whether Claims 58, 79, 101, and 123 are patentable under 35 U.S.C. §103(a) based on Benner in view of Hepworth and further in view of Khan.

Whether Claims 69, 93, 115 and 139 are patentable under 35 U.S.C. §103(a) based on Benner in view of Hepworth.

Whether Claims 68-86, 90-108, 112-130, 134-137, and 139 are patentable under 35 U.S.C. §103(a) based Hepworth in view of U.S. 4,498,402 to Kober, et al.

**(vii) ARGUMENT.**

*Whether claims 24-26, 33-34, 36, 44-66, 73, 78-81, 87-88, 95, 100-102, 109-110, 122-124, 131-132, and 140-141 comply with 35 U.S.C. §112, first paragraph.*

Before discussing this rejection, it is important to understand the procedural posture of this appeal. The present application was filed to invoke an interference with U.S. 6,484,651 to Shepard, Jr., et al. (hereinafter "Shepard") (attached hereto as Exhibit "3"). (See REQUEST BY APPLICANTS FOR INTERFERENCE PURSUANT TO 37 CFR § 1.607 AND PRELIMINARY AMENDMENT filed July 18, 2003). The objectionable language in the above claims, namely "fluid temperature" was copied from the Shepard patent.

The Examiner bears the burden of establishing a prima facie case why persons skilled in the art would not recognize in the specification disclosure a description of the claimed invention.

Section 112, first paragraph, requires, *inter alia*, that the specification shall contain a written description of the invention, and of the manner and process of making and using it so as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the invention.

The Examiner bears the burden of providing the prima facie case to support the rejection of any application. As stated by the Board of Patent Appeals and Interferences, "the examiner has the initial burden of presenting evidence or reasons why persons skilled in the art would not recognize in [the] specification disclosure a description of the invention defined by the claims. *Ex Parte Sorenson*, 3 USPQ2d 1462, 1463 (B.P.A.I. 1987). The Federal Circuit has stated that "the test for sufficiency of support in a parent application is whether the disclosure of the application relied upon 'reasonably conveys to the artisan that the inventor had possession at that time of the later claimed subject matter.' *Ralston Purina Co. v. Far-Mar-Co, Inc.*, 772 F.2d 1570, 227 USPQ 177 (Fed. Cir. 1985).

"Upon reply by applicant, . . . [the examiner is required to] fully respond to applicant's rebuttal arguments, and properly treat any further showings submitted by

applicant in the reply. When a rejection is maintained, any affidavits relevant to the 35 U.S.C. 112, para. 1, written description requirement, must be thoroughly analyzed and discussed in the next Office action.” MPEP §2163.02.

The specification need not literally recite a claim limitation for a claim to satisfy the requirements of Section 112, first paragraph.

“It is not necessary that the application describe the claim limitations exactly . . . but only so clearly that persons of ordinary skill in the art will recognize from the disclosure that appellants invented processes including those limitations.” *In re Wertheim*, 541 F.2d 257, 191 USPQ 90, 96 (C.C.P.A. 1976). “Satisfaction of the ‘written description’ requirement does not require in *haec verba* antecedence in the originally filed application.” *Staelhein v. Secher*, 24 USPQ2d 1513 (B.P.A.I. 1992). In *Ex parte Parks*, the Board further elaborated:

Adequate description under the first paragraph of 35 U.S.C. 112 does not require *literal* support for the claimed invention . . . Rather, it is sufficient if the originally-filed disclosure would have conveyed to one having ordinary skill in the art that an appellant had possession of the concept of what is claimed.

*Ex parte Parks*, 30 USPQ2d 1234 (B.P.A.I. 1994) (emphasis in original).

“While there is no *in haec verba* requirement, newly added claim limitations must be supported in the specification through express, *implicit*, or *inherent* disclosure.” MPEP § 2163(I)(B) (emphasis supplied.); see, e.g., MPEP § 2163.02. Moreover, the U.S. Court of Appeals for the Federal Circuit in *Eiselstein v. Frank*, 52 F.3d 1035, 1038 (Fed. Cir. 1995), reviewed the need for literal support for claim language in the specification and stated:

In order to determine whether a prior application meets the “written description” requirement with respect to later-filed claims, the prior application need not describe the claimed subject matter in exactly the same terms as used in the claims; it must simply indicate to persons skilled in the art that as of the earlier date the applicant had invented what is now claimed. . . . The test is whether the disclosure of the application relied upon reasonably conveys to a person skilled in the art that the inventor had possession of the claimed subject matter at the time of the earlier filing date (citing *Vas-Cath Inc. v. Mahurkar*, 935 F.2d 1555 (Fed. Cir. 1991) and *Ralston Purina Co. v. Far-Mar-Co, Inc.*, 772 F.2d 1570 (Fed. Cir. 1985)) (internal citations omitted).

By way of illustration, “where no explicit descriptions of a generic invention is to be found in the specification . . . mention of representative compounds may provide an implicit description upon which to base generic claim language.” MPEP § 2163(I)(B)(3)(b) (quoting *In re Smith*, 458 F.2d 1389, 1395, 173 USPQ 679, 683 (CCPA 1972). By way of further example, “[b]y disclosing in a patent application a device that inherently performs a function

or has a property, operates according to a theory or has an advantage, a patent application necessarily discloses that function, theory or advantage, *even though it says nothing explicit concerning it.*" MPEP § 2163.07(a) (emphasis supplied.) "The application may later be amended to recite the function, theory, or advantage without introducing prohibited new matter." MPEP § 2163.07(a). Inherent properties which do not constitute new matter are those which would be obvious to one skilled in the art from the very nature of the material. *Kennecott v. Kyocera*, 835 F.2d 1149 (Fed. Cir. 1987) (parent application contained adequate support for later filed CIP application's new disclosure of microstructure of ceramic particle where only ceramic particle, and not its microstructure, was described in parent application); *Ex parte Ayers, et al.*, 108 USPQ 444 (POBA 1955); *see, e.g., In re Nathan, et al.*, 328 F.2d 1005, 140 USPQ2d 601 (CCPA 1964) (stereo configuration of a compound is not new matter); *Ex parte Davission, et al.*, 133 USPQ 400 (POBA 1958) (physical properties of a compound, e.g., optical rotation data and elemental analysis of a disclosed salt, are inherent properties of a compound which can be added to the disclosure after filing); *In re Bowden et al.*, 183 F.2d 115, 86 USPQ 419 (CCPA 1950) (since chemical reactions are frequently unpredictable a specification may be amended at the proper time to supply corrected data subsequently discovered or which is implicit in the application as filed); *Tektronix, Inc. v. United States, et al.*, 165 USPQ 392 (Ct. Cls 1970).

Claimed subject matter that is not explicitly disclosed in the specification but is disclosed inherently by the specification satisfies Section 112, first paragraph.

Indeed, unstated subject matter satisfies the written description requirement when it is inherently disclosed in the specification. In *In re Smythe*, the court stated:

*By disclosing in a patent application a device that inherently performs a function, operates according to a theory, or has an advantage, a patent applicant necessarily discloses that function, theory or advantage even though he says nothing concerning it. The application may later be amended to recite the function, theory or advantage without introducing prohibited new matter.*

*In re Smythe*, 480 F.2d 1376, 178 USPQ 279, 285 (C.C.P.A. 1973) (emphasis supplied).

"To establish inherency, the extrinsic evidence 'must make clear that the missing descriptive matter is necessarily present in the thing described in the reference, and that it would be so recognized by persons of ordinary skill. Inherency, however, may not be established by probabilities or possibilities. The mere fact that a certain thing may result from a given set of circumstances is not sufficient.'" MPEP§2163(I)(B)(3)(b) (quoting *In re*

*Robertson*, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999); see also MPEP § 2163.07(a).

Thus, lack of literal support for specific claim terms is not enough to support a rejection under 35 U.S.C. § 112 where one of skill in the art would understand from the disclosure that the inventors had possession of the invention, as claimed, at the time of filing. The declarations of Dr. Bisque (Bisque Declaration) and Dr. Durham (Durham Declaration), both filed July 29, 2004, are evidence of precisely this understanding by one skilled in the relevant art. The Examiner cannot discount the statements of Dr. Bisque by simply stating that the declaration is unpersuasive. The MPEP requires more. The Examiner needs to provide factual reasons explaining why the declaration is not persuasive; that is, why it fails to establish why one of ordinary skill in the art would not reasonably conclude that the inventor had possession of the claimed invention. This the Examiner has failed to do. In fact, the Examiner seems to acknowledge that the declaration is sufficient under the law by stating that the applicant is relying on “inherency” to justify the support of the claims under 35 U.S.C. § 112, first paragraph. As noted above, “inherency” establishes compliance with the written description requirement.

Nonetheless, applicant will summarize the contents of the declarations and revisit, in view of the above statement of the law, why the above assertions of the examiner are incorrect.

1. The Examiner's assertion that there is no support in the Specification for the limitations that at least a portion of the iron bearing material fluxes the ash slag to produce an ash slag having a fluid temperature less than the fluid temperature of a second ash slag produced from combustion of the solid fuel alone (Claims 24, 87, 109, 131, and 140-141).

Claim 24 requires at least a portion of the iron bearing material to flux the ash slag to produce an ash slag having a fluid temperature less than the fluid temperature of a second ash slag produced from combustion of the solid fuel alone. Claims 87, 109, and 131 each require, during the combustion of the solid fuel in the presence of the iron-bearing material, that the fluid temperature be less than the fluid temperature of an ash slag produced from combustion of the solid fuel alone. Claim 140 requires the boiler to be a slag-tap furnace while claim 141 requires the solid fuel boiler to be used for at least one of steam production and electricity generation.

The claimed invention and U.S. 6,484,651 to Shepard, Jr., et al., (Exhibit “3”) use the same reactants under the same reaction conditions in the same reactor to produce the same result, namely the production of a slag having a lower viscosity than a slag produced by combustion of coal alone.

Before responding to the Examiner’s rejections, it is important to understand the overlap between the claimed subject matter of Shepard, Jr. et al., and the present application (“the Subject Application”) and U.S. Provisional Application 60/213,915, filed June 26, 2000 (“the Provisional Application”), which was incorporated by reference in its entirety in the Subject Application. They each disclose the combustion of the same fuel in the same type of combustion chamber in the presence of the same iron-bearing material additive under the same temperature regime. The fuel is a low sulfur western or eastern coal (*see, e.g.*, Provisional Application at pages 1 and 3; Subject Application at Figure 2, page 2, lines 15-17, page 3, lines 9-12, page 4, lines 3-4 and 7-9, and page 6, lines 4-5; and Shepard Patent at col. 1, line 62-col. 2, line 3, col. 3, lines 26-34 and 55-57and Fuels 3 and 4). The combustion chamber is a “slag tap” or “wet bottom” boiler, such as a cyclone-type boiler (*see, e.g.*, Provisional Application at pages 1-5 and 7-8; Subject Application at Figure 1, page 1, lines 18-26, page 5, lines 16-17, page 6, lines 4-5 and 15-18, and page 18, lines 12-13; and Shepard Patent at col. 2, lines 7-8, col. 4, lines 7-10). The iron-bearing material is mill scale from steel production or dust from blast furnace gas cleaning equipment (*see, e.g.*, Provisional Application at pages 4 and 6; Subject Application at page 12, lines 7-12; and Shepard Patent at col. 4, lines 15-16, col. 8, lines 4-5). The temperature regime is that necessary to combust the solid fuel and melt the ash content of the fuel to form slag. (*see, e.g.*, Provisional Application at pages 1-5 and 7-8; Subject Application at page 2, lines 14-15, page 6, lines 4-5 and lines 15-18, Figures 7-8 and page 20, lines 1-21; and Shepard Patent at col. 2, lines 4-50, col. 5, lines 10-50). In chemistry, it is elementary that the use of the same reactants under the same reaction conditions in the same reactor will produce the same results. (Declaration of Ramon Bisque filed July 29, 2004, at ¶8 (Bisque Declaration attached hereto as Exhibit “1”). This conclusion is consistent with the teachings of Shepard et al., and the subject application. Regarding the results from adding the iron-bearing material, Shepard et al. and the subject application *both* teach that the iron-bearing material fluxes the ash formed from the solid fuel, thereby causing the slag to have a lower viscosity than a slag produced by combustion of the coal alone. (Shepard et al. at col. 2, lines 42-47 and lines 58-61; col. 4, lines 22-25; col. 5, line 51-col. 6, line 10; col. 6, lines 52-56; col. 6, line 60-col. 7, line 9; col. 7, lines 43-47; col. 7, lines 57-63; col. 8, lines 7-13; col. 9, lines 21-

26; col. 9, lines 56-60; col. 9, line 66-col. 10, line 26; col. 10, lines 52-54; and claim 5; Subject Application at page 18, line 10; page 5, lines 13-17; page 6, lines 19-22; page 7, lines 15-22; page 8, lines 9-10; page 9, lines 14-15; and page 20, lines 1-19.

While applicants use ash melting point to measure the effect of fluxing by the iron-bearing material, Shepard et al. uses ash fluid temperature. For western coals, a reduction in melting temperature necessarily equates to a reduction in ash fluid temperature. (Bisque Declaration at ¶18.)

It is well accepted that fluid temperature f the ash and melting temperature of the ash are equivalent.

One method of determining the different Ash Fusion Temperature ("AFT") characteristics corresponding to the melting temperature of the ash is set forth at pages 20-5 through 20-7 of "*Steam/its generation and use*", by Babcock & Wilcox (1972) ("the Babcock & Wilcox Article" attached to the Bisque Declaration, in which the AFT properties are determined as part of the ASTM Standard D 1857, *Fusibility of Coal and Coke Ash.*") According to the standard, an ash sample is prepared by burning coal under oxidizing conditions at temperatures of 1470 to 1650°F. The ash is pressed into a mold to form a triangular pyramid cone 0.75 in. in height with a 0.25 in. triangular base. The cone is heated in a furnace at a controlled rate to provide a temperature increase of 15° F per minute. The initial deformation temperature (IT or ID) refers to the temperature at which the tip of the pyramid begins to fuse or show signs of deformation. The softening temperature (ST) is the temperature at which the sample has deformed to a spherical shape where the height of the cone is equal to the width at the base (H=W). The softening temperature is commonly referred to as the fusion temperature. The hemispherical temperature (HT) is the temperature at which the cone has fused down to a hemispherical lump and the height equals one half the width of the base (H=1/2 W). The fluid temperature (FT) is the temperature at which the ash cone has *melted* to a nearly flat layer with a maximum height of 0.0625 in. (See Bisque Declaration at ¶14.)

There are two fluid temperatures that can be measured. The above fluid temperature is known as the "fluid temperature 0.625 in.". (See page 8-9 of Babcock & Wilcox attached hereto as Exhibit "S"). The fluid temperature at which the molten ash viscosity is no more than 1/16<sup>th</sup> in. (0.15 cm) is known as the "fluid temperature flat." (*Id.*)

It is accepted that the melting point of ash is the same as its fluid temperature. "Steam its generation and use", published by Babcock & Wilcox Company (1992), which is attached hereto as Exhibit "A" to the Bisque Declaration ("Exhibit 1" hereto), states at page 21-6:

*Fluid Temperature (FT) – the temperature at which the ash cone has melted to a nearly flat layer with a maximum height of 0.0625 in. (1.59 mm).*

(Emphasis supplied.)

Accordingly, an established, reliable, respected, and objective article has equated ash melting temperature with its fluid temperature.

Because coal is a mixture of differing minerals and has no distinct melting point, one of ordinary skill in the art would understand ash "melting temperature" (Specification at pages 2, 7, 20 and Abstract) and ash "melting" (Specification at pages 1-2, 6-7, 8, and 20) to refer to ash fluid temperature and ash fluidity, respectively.

*Coal Properties, Sampling & Ash Characteristics*, by Rod Hatt (which is attached hereto as Exhibit "2") states at page 4:

Lets [sic] start our review with an overview of coal mineralogy and its relationship to coal ash chemistry, melting & slagging properties, and fusion temperature. There are not [sic] melting points for coal ash like with ice or other pure compounds, so when melting is mentioned it is used to represent a decrease in viscosity, rather than a melting point. When coal ash melts it occurs on both a large scale and a microscopic scale. On the large or bulk scale the ash behaves like a glass. As the temperature of the material increases, its viscosity decreases. At temperatures less than 2000°F, the ash may appear solid, or at least stiff, such as a Tootsie Roll. On a microscopic scale several minerals may have all ready melted, but their concentrations are low when compared to other minerals with higher melting temperatures. As the temperature is increased the ash becomes less viscous or more liquid like. Many reactions are now occurring between the minerals as they melt and become more fluid. As the molten components mix they become more like molten glass. This molten material starts to dissolve the non molten materials like quartz and other minerals. In this way the melting temperature of minerals such as sandstones and shales are lowered by other minerals such as pyrite and limestone.

(Emphasis supplied.)

Based on the statement in the above quotation that one of ordinary skill in the art would understand ash "melting" to represent a decrease in slag viscosity, rather than a distinct melting point, one of ordinary skill would understand ash "melting" to refer to the fluidity of liquefied ash or slag. Thus, one of ordinary skill in the art would understand ash

"melting point" to be a temperature at which the ash is fluid, which is also the fluid temperature of the ash.

Regarding ash melting, the Babcox and Wilcox article states at page 20-6:

The gradual deformation of the ash cone is generally considered to result from differences in melting characteristics of the various ash constituents. As the temperature of the sample is increased, compounds with lowest melting temperature begin to melt, causing the initial deformation. As the temperature continues to increase, more of the compounds melt and the degree of deformation proceeds to the softening and hemispherical stages. *The process continues until the temperature is higher than the melting point of most of the ash constituents and the fluid stage is reached.*

(Emphasis supplied.)

Contrary to the Examiner's assertion that fluid temperature and melting temperature refer to differing properties, the above quotations amply demonstrate that ash fluid temperature is equated in the art with ash melting and melting point. (See Bisque Declaration at ¶¶13 and 15.)

The Provisional and Subject Applications' use of the terms "flux" and "fluxing agent" conveys to one of ordinary skill in the art that the ash melting temperature, or fluid temperature, is lowered by the iron-bearing additive.

Regarding the AFT-characteristic limitation and the fluxing limitation, namely that the "iron bearing material fluxes the ash slag" in claims 1, 11, 19, 24 and 33 (see Office Action at pages 3, 4, 5, and 33), the Provisional and Subject Applications further use the term "flux" and "fluxing agent". (Provisional Application at pages 1, 3-4, and 6-8 and Subject Application at page 5, lines 13-14, page 6, lines 19-22, page 8, lines 10-11).

The Subject and the Provisional Applications each state that the iron-bearing additive fluxes the ash and lowers the melting temperature of the ash. See e.g. Provisional Application at page 3, "[i]t is the use of these byproducts of steel and iron manufacturing to flux the ash and improve the cyclone operation that is new and unique" and at page 1 "[t]he iron both reduces the melting temperature of the ash, and reduces the slag viscosity at these temperatures due to the presence of iron aluminosilicate crystals in the ash." (Emphasis added). See e.g. Subject Application at page 6, lines 19-22, "[t]he iron-containing additive can be in any form and any composition so long as iron is present in sufficient amounts to flux effectively the feed material" (emphasis supplied) and page 7, lines 15-18 "...it is believed that the presence of iron in the calcium aluminosilicate slags of western coals causes a decrease in the melting temperature of the ash and crystal formation in the melt when a

critical temperature ( $T_{cv}$ ) is reached." See also page 5, lines 13-14 page 8, lines 10-11, Figs. 7-8 and page 20, lines 1-21 of the Subject Application. According to *Hawley's Condensed Chemical Dictionary*, "flux" is defined as "[a] substance that promotes fusing of minerals or metals or prevents the formation of oxides." It further defines "fuse" as "[o]f a solid, to melt, e.g., a fused salt." (Emphasis supplied.)

The terms "flux" and "fuse" would further suggest to one of ordinary skill in the art that the melting temperature, or fluid temperature, is lowered by the iron-bearing additive disclosed in the Provisional and Subject Applications. (Bisque Declaration at ¶17.)

The Provisional and Subject Applications' statement that the iron-containing additive lowers the  $T_{250}$  of low-sulfur coals conveys to one of ordinary skill in the art that the ash melting temperature, or fluid temperature, of the ash, is lowered by the iron-bearing additive.

The Provisional and Subject Applications further refer to the iron-containing additive lowering the  $T_{250}$  (or the temperature at which the ash would have a viscosity of 250 poise and is an important indicator for the minimum temperature at which the slag will flow) for low-sulfur eastern and western coals having low iron and high calcium contents. (Provisional Application at pages 1 and 4-5 and Subject Application at Figure 2, page 2, lines 15-17, page 7, lines 15-18, page 9, lines 14-15, page 19, lines 5-10, Figures 7-8 and page 20, lines 3-21). As shown in Figures 7-8 of the Subject Application, the iron-containing additive lowers the slag viscosity, at temperatures above about 2275°F, compared to a slag when no additive is used. It is inherent that the use of the iron-bearing material to lower the  $T_{250}$  of low-sulfur coals having low iron and high calcium contents will lower each of the AFT properties referenced above. (Bisque Declaration at ¶¶18 and 20.) Shepard is directed to combustion of low-sulfur coals having low iron and calcium (lower basicity) (col. 3, lines 19-34; col. 7, lines 42-56; Table I; and Fig. 3) in the presence of the iron-containing additive to reduce viscosity (i.e. AFT characteristics) (col. 7, line 57; col. 8 line 6).

The Subject and Provisional Applications each state that the iron-bearing additive fluxes the ash and lowers the ash melting temperature, which statements are alternate expressions for and inherently state that the additive lowers the fluid temperature of the AFT characteristics.

As noted above, the Specifications of the Subject and Provisional Applications literally state that the iron-bearing additive fluxes the ash and, as a resulting, lowers the

melting temperature of the ash. The fluid temperature is simply an alternate way of defining ash melting temperature and viscosity in the same manner that inches and centimeters are alternative measures for length. As set forth in the Declaration of Dr. Ramon Bisque under 37 CFR § 1.132 ("Bisque Declaration"), attached hereto as Exhibit A, which was submitted in the previous Office Action Response of July 29, 2004, the AFT characteristics of initial deformation temperature, softening temperature, hemispherical temperature, and fluid temperature represent a *continuum of constituent melting points* leading to the *ultimate* melting temperature of the ash. (See Bisque Declaration at ¶13.) One of ordinary skill in the art would understand the phrase, "melting temperature of the ash" (as used in the Subject and Provisional Applications), to refer to the last (or highest) of a sequence of melting points for differing ash constituents and require that each of the lower melting point constituents have melted. The melting temperature of the ash is therefore synonymous with the fluid temperature. (Bisque Declaration at ¶16.)

Shepard admits that lowering the AFT characteristics in low sulfur coals will necessarily lower the viscosity by adjusting the base-to-acid ratio of the coal.

Shepard, the patent for which Applicants are requesting declaration of an interference, admits that the AFT characteristics are simply a way of measuring the ash viscosity, which is proportional to the melting point or temperature of the ash. Shepard admits that slag tap boilers require ash having low AFT characteristics. (Col. 5, lines 51-58.) It admits that lower sulfur coals generally have ash chemistry and AFT characteristics that are outside the range for which slag tap or cyclone boilers were originally designed because lower sulfur coals have higher AFT characteristics (i.e., higher IDT, ST, HT, and FT) than is desirable for proper ash flow from the bottom of the boiler. (Col. 3, lines 19-34.) It admits that adding suitable amount of iron-bearing material to low sulfur coals with high AFT characteristics will adjust the base-to-acid ratio and ultimately the ash viscosity characteristics to render the low sulfur coals suitable for use in slag tap boilers because the iron-bearing material will adjust the iron content of the slag to more closely resemble that characteristic of coal having low AFT characteristics. (Col. 7, lines 47-56, and col. 9, lines 21-30, and col. 10, lines 21-26.)

Accordingly, based on Shepard, the present application's disclosure that the iron-containing additive lowers the viscosity and melting temperature of low sulfur coal and acts as a fluxing agent would necessarily disclose to one of ordinary skill in the art that the iron-containing additive lowers the fluid temperature of the low sulfur coal.

2. The Examiner's assertion that there is no support in the Specification for the requirements that the fluid temperature be less than 2600°F (Claims 66, 88, 110, and 132).

Claims 66, 88, 110, and 132 require that the ash fluid temperature be less than 2600°F.

The Provisional Application at page 1 and the Subject Application at page 2, lines 14-15, disclose that ash, in the absence of the iron-containing additive, melts at normal combustion temperatures ranging from 2600 to 3000°F. The Subject Application and the Provisional Application thereafter each state that the iron-bearing additive fluxes the ash and lowers the melting temperature of the ash. See e.g. the Subject Application at page 7, lines 15-18 "...it is believed that the presence of iron in the calcium aluminosilicate slags of western coals causes a decrease in the melting temperature of the ash and crystal formation in the melt when a critical temperature ( $T_{cv}$ ) is reached." As discussed in the Bisque Declaration at ¶¶13 and 16, the AFT characteristics refer to a continuum of ash component melting points with the last (or highest) of the continuum of melting points being the melting temperature of the ash or AFT characteristic fluid temperature.

From the statements in the Provisional and Subject Applications that the ash, in the absence of the iron-containing additive, melts at temperatures ranging from 2600°F to 3000°F and that the ash melting temperature is reduced by the iron-containing additive, it follows deductively that the melting temperature or the AFT characteristic fluid temperature of the ash is reduced and less than 2600°F.

The Bisque Declaration further states in ¶22 as follows:

I disagree. The Provisional Application at page 1 and the Subject Application at page 2, lines 14-15, disclose that the ash (from which the molten slag is formed), in cyclone boilers, must be melted at normal combustion temperatures ranging from 2,600 to 3,000°F. Moreover, the Subject Application at page 20 and in Figure 7 shows that the ash/slag is melted at a temperature below 1,900°F.

Thus, the elements of Claims 66, 88, 110, and 132 are described in the specifications of both the Provisional and Subject Applications in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time each of the applications was filed, had possession of the claimed invention.

3. The Examiner's implication that claims 140-141 lack support in the Specification.

The Examiner rejects these claims under Section 112, first paragraph. These claims are supported in the Specification. Support for claim 140 includes page 1, lines 18-25; Figure 1; page 1, line 24 through page 2, line 19; page 6, lines 6-19; Figure 9; page 14, line 1; page 18, line 10. Support for claim 141 includes page 8, lines 1-3; page 12, lines 3-6; page 1, lines 18-19; page 12, lines 14-17; page 10, lines 1-3; page 18, line 10.

4. The Examiner's requirement of explicit disclosure to comply with the written description requirement is unsupported by the law.

MPEP§2163.07(a) states that disclosing a device that inherently performs a function or has a property, operates according to a theory or has an advantage necessarily discloses that function, theory or advantage, *even though it says nothing explicit concerning it.*" (Emphasis supplied.) "*The application may later be amended to recite the function, theory, or advantage without introducing prohibited new matter.*" *In re Reynolds*, 443 F.2d 384, 170 USPQ 94 (CCPA 1971); *In re Smythe*, 480 F.2d 1376, 178 USPQ 279 (CCPA 1973).

5. The Examiner has failed to rebut Applicants' evidence that, at the time the applications were filed, one of ordinary skill in the art would recognize, in the specification disclosure of the Provisional and Subject Applications, a description of the invention defined by the claims.

"The examiner has the initial burden of presenting evidence or reasoning to explain why persons skilled in the art would not recognize in the original disclosure a description of the invention defined by the claims." MPEP§2163(I)(B)(3)(b). "The examiner, therefore, must have a reasonable basis to challenge the adequacy of the written description. The examiner has the initial burden of presenting by a preponderance of evidence why a person skilled in the art would not recognize in an applicant's disclosure a description of the invention defined by the claims." MPEP§2163.04. Further, "[u]pon reply by applicant, . . . [the examiner is required to] fully respond to applicant's rebuttal arguments, and properly treat any further showings submitted by applicant in the reply. When a rejection is maintained, any affidavits relevant to the 35 U.S.C. 112, para. 1, written description requirement, must be thoroughly analyzed and discussed in the next Office action." MPEP§2163.02.

The Nissen reference, cited by the Examiner to support his finding that the Subject and Provisional Applications fail to provide support for ash fluid temperature, actually supports the equivalence of ash fluid temperature and ash melting point or temperature.

At page 2 of the Office Action dated August 15, 2008, the Examiner attempts to rebut Applicants' evidence that a person skilled in the art would recognize in the applicant's disclosure a description of the invention defined by the claims. The Examiner has failed to respond as required by Section 112 to the Applicant's arguments in the Applicant's response dated March 24, 2008.

By way of example, the Examiner states simply:

As evidenced by Niessen the fluid temperature and melting point are two different physical properties. Consequently, since the specification is silent as to the term "fluid temperature" the specification would not have reasonably conveyed to one of ordinary skill that the application was in possession of the subject matter at the time of filing.

Nowhere is Niessen cited. Applicants assume that the single page entitled "Stoichiometry" attached to the Office Action is an excerpt from Niessen. For the convenience of the Examiner, this page is attached hereto as Exhibit "3". Because Applicant does not have a cite to Niessen, Applicant is unable to examine the context of discussion from which the page is taken. It appears that the reference is made in the context of an incinerator and not a coal furnace.

As can be seen from Exhibit "3", this page defines "Fluid Temperature" as "where the molten ash viscosity is very low and the material flows down the plate with a thickness *not greater* than 1/16<sup>th</sup> (0.15 cm). (Emphasis supplied.) This is the "flat" fluid temperature. (Exhibit "5"). "Molten" is defined as "melted or liquefied by heat". *Webster's New World Dictionary* (2<sup>nd</sup> Ed.). The thickness of the molten ash, or slag, is required to be *not more than* 1/16<sup>th</sup> inch or 0.15 cm. This thickness describes fully melted ash and ash at its "melting point". As noted by the Bisque Declaration (Exhibit "1"), the melting temperature or point of ash is the temperature at which "each of the lower melting point constituents have melted." (Bisque Declaration at ¶16.) *The attached page thus indicates that one of ordinary skill in the art would construe the term "melting temperature" or "melting point" (used in the Specification) in the context of ash to be the same as ash fluid temperature.*

Brenner, another reference cited by the Examiner, defines ash "melting temperature" or "melting point" to be the same as ash "fluid temperature".

In addition to the previously discussed articles and Bisque Declaration, Brenner, a reference cited by the Examiner, is instructive on how one of ordinary skill in the art could

construe the term "melting point" of ash. According to Brenner, the "melting point" of the ash is:

the temperature at which it will prevent accumulation of slag on the furnace walls beyond a skin or coating which has been formed over the walls (which coating is produced by the air and/or water cooling of the furnace walls) and the congealing or setting of the slag in immediate contact therewith.

(page 2, lines 68-76.) This definition mirrors the fluid temperature definition of the page attached by the Examiner; therefore, one of ordinary skill in the art would understand, as synonymous, the melting point or temperature of the ash on the one hand with fluid temperature on the other.

*The above quoted passages and paragraphs 14 and 16 of the attached Bisque Declaration abundantly establish that one of ordinary skill in the art would understand the terms "melting temperature" or "melting point" of the ash on the one hand and "fluid temperature" of the ash on the other hand to be synonymous.*

**The Examiner has dismissed the Bisque Declaration on improper grounds.**

In the Office Action mailed May 1, 2006, the Examiner states:

Paragraphs 14 and 15 of the Bisque declaration does [sic] not appear to support the conclusion that the terms melting point and ash fusion temperature are synonymous. Per the Bisque declaration the fluid temperature (FT) is defined as the temperature at which the ash cone *has melted* to a nearly flat layer with a maximum height of 0.0625 inches and requiring visual observation. This term does not appear to be synonymous with the term melting temperature. Consequently one of ordinary skill would not reasonably conclude that the inventor had possession of the claimed invention.

(Emphasis supplied)

In the final Office Action mailed December 6, 2006, the Examiner further states that "the affidavits were not prepared by disinterested third parties but by interested parties." (Final Office Action at p. 2.)

These paragraphs fail to provide supporting facts in at least two respects.

First, why does it "appear" that the terms melting point and fluid temperature are not synonymous. Apart from the fact that the declarant has stated under oath that this is the case, the Examiner fails to explain his position. The Examiner's own definition of fluid temperature references "melting" and requires the thickness of the melted ash to be no more than a specified thickness (which maximum thickness is synonymous with a melted ash layer). The definition further requires the ash cone (which has a standard size) to be liquefied. "Melt is defined by Webster's New World Dictionary as "to change from a solid to

a liquid state, generally by heat". According to the Examiner's own definition, the fluid temperature is the temperature at which the last of the ash constituents has melted, or the ash melting temperature.

Second, the Examiner concludes, without support, that "one of ordinary skill would not reasonably conclude that the inventor had possession of the claimed invention." This conclusion is not only contrary to the conclusions in the Bisque Declaration but also does not follow from the prior sentences. As noted, the Bisque declaration and the Provisional and Subject Applications make clear that the iron-containing additive acts as a fluxing agent, reduces the T<sub>250</sub> temperature, reduces viscosity, and reduces the ash melting temperature. Even if fluid temperature is not synonymous with ash melting temperature, it still does not follow that the Provisional and Subject Applications do not convey to one of ordinary skill in the art at the time they were filed that the inventor had possession of the claimed invention.

Finally, the dismissal of affidavit evidence simply because it is not from a disinterested party is not a sufficient basis for failing to consider the affidavit. MPEP§716.01(a) states that affidavits or declarations, when timely presented, *must* be considered by the examiner in determining issues of patentability, particularly under 35 U.S.C. §103. MPEP§2163.07(a) states that extrinsic evidence is used to establish inherency and does not require that the extrinsic used to establish compliance of an amendment with the written description requirement be from a disinterested third party.

Accordingly, claims 24-26, 33-34, 36, 44-66, 73, 78-81, 87-88, 95, 100-102, 109-110, 122-124, 131-132, and 140-141 comply with 35 U.S.C. §112, first paragraph.

*Whether Claims 24-26, 33-34, 36, 44-66, 68-88, 90-110, 112-132, 134-137, and 139-141 are patentable under 35 U.S.C. §103(a) based on U.S. 1,955,574 to Benner in view of U.S. 4,572,085 to Hepworth and further in view of one or more of U.S. 4,886,521 to Khan, U.S. 3,896,746 to Pirsh, and U.S. 4,089,507 to Arai, et al.*

35 U.S.C. §103(a) states that a patent may not be obtained . . . if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

The key to supporting any rejection under 35 U.S.C. §103 is the clear articulation of the reason(s) why the claimed invention would have been obvious. The Supreme Court in *KSR International Co. v. Teleflex Inc.*, 550 U.S. \_\_\_, \_\_\_ 82 USPQ2d 1385, 1396 (2007)

noted that the analysis supporting a rejection under 35 U.S.C. §103 should be made explicit. The Federal Circuit has stated that "rejections on obviousness cannot be sustained with mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness." *In re Kahn*, 441 F.3d 977, 988, 78 USPQ2d 1329, 1336 (Fed. Cir. 2006). See also KSR, 550 U.S. at \_\_\_, 82 USPQ2d at 1396 (quoting Federal Circuit statement with approval).

If the examiner determines there is factual support for rejecting the claimed invention under 35 U.S.C. §103, the examiner must then consider any evidence supporting the patentability of the claimed invention, such as any evidence in the specification or any other evidence submitted by the applicant. The ultimate determination of patentability is based on the entire record, by a preponderance of evidence, with due consideration to the persuasiveness of any arguments and any secondary evidence. *In re Oetiker*, 977 F.2d 1443, 24 USPQ2d 1443 (Fed. Cir. 1992). The legal standard of "a preponderance of evidence" requires the evidence to be more convincing than the evidence which is offered in opposition to it. With regard to rejections under 35 U.S.C. §103, the examiner must provide evidence which as a whole shows that the legal determination sought to be proved (i.e., the reference teachings establish a *prima facie* case of obviousness) is more probable than not.

1. Benner teaches away from adding an iron-containing material to the coal boiler or furnace (Claims 24, 68, 90, 112, and 134).

Benner is directed to additives to raise or lower the melting point of ash to produce, during furnace operation, a thin layer of solid or very viscous slag on the furnace wall. This is realized when the flame temperature is between 50 to 350°C above the softening point of the ash as determined by pyrometric cones. The additives are rouge and fluxing or fusible clay to increase the melting point of the ash. (page 3, lines 23-51.) The clay additive is non-ferruginous (page 1, lines 71-75.) Ferruginous clays are clays that contain or have the nature of iron. *Webster's New World Dictionary* (2<sup>nd</sup> Ed.). Therefore, non-ferruginous clays do not contain or have the nature of iron. While acknowledging that the presence of iron can, depending on whether the atmosphere is oxidizing or reducing, be a chief cause of the melting point of the ash, Benner's use of non-ferruginous clay *teaches away* from adding iron to influence ash melting point. Iron-containing clays are disfavored because fire-clay bricks erode in the presence of iron (page 2, lines 103-112). The only additives Benner discloses are sand and non-ferruginous clays (to raise the softening point) and lime or soda (to lower the softening point).

2. Hepworth teaches adding taconite and mill scale to control sulfur oxide emissions and says nothing about its impact on melting or fluid temperatures. (Claims 24, 68, 90, 112, and 134).

Hepworth is directed to a process for combusting sulfur-containing coal in a single step while producing an off-gas low in sulfur. The process comprises combusting finely divided coal in a furnace burner cavity in the presence of a finely divided iron oxide or iron powder and at least about 60% of the oxygen stoichiometrically required for substantially complete combustion of the coal to form a liquid iron oxysulfide phase and a turbulent atmosphere of combustion-product gases, liquid iron oxysulfide acting to scrub sulfur-containing gaseous species from the atmosphere to yield an essentially sulfur-free flue gas and a liquid iron oxysulfide slag containing substantially the sulfur originally contained in the coal.

The process specifically discloses using fine high-sulfur coal and taconite or mill scale in a cyclone furnace to yield an essentially sulfur-free flue gas and a liquid iron oxysulfide slag containing essentially all of the sulfur in the feed coal. Hepworth states that “thermodynamic efficiency of the desulfurization process is improved since wustite serves as a diluent or solvent for FeS and reduces the H<sub>2</sub>S pressure in equilibrium with the liquid, thereby contributing further to desulfurization of the gas.” (Col. 5, lines 17-21.) Hepworth is silent about the effect of the iron oxide additive in lowering the melting point of the ash or in increasing slag viscosity.

4. Hepworth teaches away from using taconite or mill scale to control melting point and rather teaches that carbon is effective in lowering the melting point (Claims 24, 68, 90, 112, and 134).

Hepworth further states that:

With the thermodynamic information available, it became possible to calculate gas compositions at the temperatures of interest. *In the calculation, the effect of carbon on the liquid phase was neglected.* The interaction coefficient is positive, indicating that carbon tends to raise the activity of sulfur. *A beneficial effect of carbon would be to lower the melting point of the liquid and hence increase its fluidity at a given temperature. The beneficial role of silica and other components in reducing the activity of the liquid was also neglected.*

(Emphasis supplied.)

Hepworth teaches away from using taconite or mill scale to control melting temperature by stating the carbon, not iron oxide, lowers the melting point of the liquid. Hepworth specifically neglected the beneficial role of "silica and other components in reducing the activity of the liquid".

3. Hepworth is directed to high-sulfur eastern coals which can be metallurgically different from low sulfur western coals (or those having a sulfur content of less than about 1.5%) and therefore one of ordinary skill in the art could not predict, based on its teachings with a reasonable degree of success, the chemical results for low sulfur coals (Claims 24, 68, 90, 112, and 134).

Hepworth is directed to controlling sulfur dioxide emissions in *high-sulfur eastern coals* (col. 2, lines 26-27, col. 4, lines 25-32, col. 6, lines 23-24, col. 7, lines 18-22, col. 7, lines 45-49). Although fluxing by the iron additive may occur in the coal combustion process described by Hepworth for specific types of coals, it is far from being certain. Indeed, the only beneficial effect of iron oxide addition explicitly taught by Hepworth is a reduction in sulfur dioxide emissions. Whether iron acts as a flux depends not only on the valence state of the iron but also the composition of the coal. The constituents of coal ash are classed as either basic or acidic. Acidic constituents are silica, alumina, and titania while the basic constituents are iron, calcium, magnesium, and alkalies. As noted at col. 7, lines 21-28, and Fig. 3 of Shepard, a higher ratio of basic constituents indicates lower AFT characteristics or melting point of a fuel and therefore the basic constituents are considered to be the fluxes. For bituminous-type ash, the principle flux, or viscosity lowering, component is Fe<sub>2</sub>O<sub>3</sub> while for lignite-type ash the principle fluxes are CaO and MgO. Switching to lower sulfur fuels will cause fuel ash with lower iron contents and lower basicity to be produced in the furnace, resulting in slag and handling problems due to higher than design ash viscosity characteristics. *Id.* at col. 7, lines 51-56.

4. Because of their divergent teachings, one of ordinary skill in the art would not combine Brenner with Hepworth to produce the claimed invention. (Claims 24, 68, 90, 112, and 134).

Brenner teaches away from ferruginous, or iron-containing, additives to influence ash softening point. Hepworth teaches that carbon, and not iron, lowers the melting point of the liquid (col. 5, lines 22-29.) Accordingly, one would not consider, and be unable to predict

success, based on this combination of references, in adding iron to lower the melting or fluid temperatures of the ash.

5. Khan, Pirsch, Arai, et al., and Kalb fail to overcome the deficiencies of Brenner and Hepworth. (Claims 24, 68, 90, 112, and 134).

Khan is directed to the production of a fuel from the pyrolysis or gasification of coal or oil shale and specifically to the production of a fuel from the pyrolysis or gasification of coal or oil shale in the presence of iron oxide in an inert gas atmosphere. Iron oxide is mixed with the coal or oil shale feed to prevent the mixture from swelling. (Col. 3, lines 24-31). Hardening of coal causes coke formation. Khan says nothing about the impact of iron oxide addition on ash melting or fluid temperature.

Pirsch is directed to a system using vapor generator heating gases as a medium for removing moisture from the fuel before it is fired. Pirsch says nothing about iron addition to coal.

Arai, et al., are directed to manufacturing reduced pellets from the dust discharged from an iron foundry or steel mill. Arai, et al., like Pirsch, say nothing about iron addition to coal.

Kalb is directed to coal drying and says nothing about iron addition to coal.

*Whether Claims 58, 79, 101, and 123 are patentable under 35 U.S.C. §103(a) based on Benner in view of Hepworth and further in view of Khan.*

Claims 58, 79, 101, and 123 are directed to the iron-containing additive including a hydrocarbon, oil, grease, and/or xanthan gum.

The Examiner admits that both Benner and Hepworth are silent on this feature.

In addition to the arguments presented above, Khan says nothing about including one or more of these components in the iron oxide additive. For this teaching, the Examiner cites col. 1, lines 65-72, and col. 2, lines 1-32. This passage does not mention any of these components let alone teach using such a compound “for the purpose of promoting removal of the slag.” (Office Action at page 5.) Khan teaches prevention of coal or oil shale swelling during pyrolysis; it says nothing about slag removal.

*Whether Claims 69, 93, 115 and 139 are patentable under 35 U.S.C. §103(a) based on Benner in view of Hepworth.*

Claims 69, 93, and 139 are require the solid fuel to include a coal having a total iron content of less than about 10 wt.% (dry basis of the ash), and wherein the coal has a calcium content of at least about 15 wt.% (dry basis of the ash). Claim 115 requires the solid fuel to have a total iron content of less than about 10 wt.% (dry basis of the ash), and wherein the solid fuel has an alkali content of at least about 20 wt. % (dry basis of the ash)

Neither Benner nor Hepworth disclose a coal having this composition. Benner teaches an Illinois bituminous coal having an Fe<sub>2</sub>O content of 7.7 wt.% and a Kentucky bituminous coal having an Fe<sub>2</sub>O content of 4.2 wt.%. Neither coal has a calcium content of about 15 wt.% or greater. Moreover, claims 69 requires the coal to be sub-bituminous. Hepworth does not teach either the iron or calcium/alkali contents in these ranges.

*Whether Claims 68-86, 90-108, 112-130, 134-137, and 139 are patentable under 35 U.S.C. §103(a) based on Hepworth in view of U.S. 4,498,402 to Kober, et al.*

The Examiner next rejects claims 68-86, 90-108, 112-130, 134-137, and 139 under 35 U.S.C. §103(a) as being unpatentable over Hepworth (U.S. 4,572,085) in view of Kober (U.S. 4,498,402).

1. Kober, et al., fail to overcome the deficiencies of Hepworth.

Hepworth is deficient for reasons noted above.

Kober, et al., fail to overcome the deficiencies of Hepworth. Kober, et al., are directed to the addition of conditioners, such as strontium carbonate, a mixture of zircon with copper oxychloride and a mixture of alumina with aluminum fluoride, zircon, or zirconyl chloride to control slagging. While disclosing low sulfur (western) coals, Kober, et al., say nothing about adding iron to coal to control melting temperature or point or fluid temperature.

2. There is no motivation to combine the teachings of Hepworth and Kober, et al.

No motivation to combine the teachings of Hepworth and Kober can be found in the prior art. To the contrary, both Hepworth and Kober teach away from the combining the references. Indeed, one of skill in the art would have no reasonable expectation of success in combining Hepworth and Kober. Thus, a *prima facie* case of obviousness has not been established.

Nor is it obvious to modify the Hepworth process to use the low sulfur coal disclosed in Kober. Hepworth states, at col. 1, lines 22-32, as follows:

Unfortunately, most of the coal supplies in the Eastern and Midwestern United States are *high in sulfur, and substitution of lower-sulfur Western coals therefore is not only expensive because of transportation cost but can cause further distress in the already economically deprived coal-mining areas.*

It is accordingly desirable that economic means be found whereby available *high-sulfur* coals could be utilized without further contributing to the atmospheric pollution problem.

(Emphasis supplied.)

According to Hepworth, the cyclone burner was developed in the 1940's particularly for the purpose of burning high sulfur Illinois coal which has a high ash content and a low ash-fusion temperature. (Hepworth at col. 1, lines 35-38.)

At col. 2, lines 26-37, Hepworth further states:

Fine *high-sulfur* coal and iron oxide are combusted in a burner cavity such as that of a cyclone furnace using at least about 60% of the oxygen stoichiometrically required for completely combusting said coal to form a liquid iron oxysulfide phase and a turbulent atmosphere of combustion-product gases, with the liquid iron oxysulfide acting to scrub sulfur-containing gaseous species from the furnace atmosphere to yield an essentially sulfur-free flue gas and a liquid iron oxysulfide slag containing essentially all the sulfur contained in the feed coal. Temperature conditions are maintained between about 1100.degree. C. and 1500.degree. C.

As can be seen from the foregoing, the invention of Hepworth is specifically directed to the combustion of high *not* low sulfur coals in cyclone boilers because lower sulfur Western coals are expensive and, if used, can cause further distress in the already economically deprived Eastern coal-mining areas. Hepworth thus *teaches away* from using, in a cyclone boiler, low sulfur coals along with the iron additive of Hepworth. Moreover, because Hepworth teaches only that the iron additive removes sulfur and says nothing about its impact on the melting point or viscosity of the slag Hepworth provides no incentive or motivation to use low-sulfur coals with the additive in a wet bottom boiler.

Furthermore, Applicant respectfully submits that one of skill in the art would not simply use the low-sulfur coal of Kober with the teaching of Hepworth to meet

environmental requirements. As discussed above, this replacement would frustrate the purpose of Hepworth, which is directed to reducing sulfur emissions by forming a liquid iron oxysulfide slag.

Moreover, one of skill in the art would have no reasonable expectation of success in combining the teachings of Hepworth and Kober due to the distinct chemical properties of high and low sulfur coals. It is well known to the skilled artisan that high and low sulfur coals differ not only in sulfur content, but also in ash content, iron content, and levels of magnesium and calcium. These chemical differences make some coals unsuitable for use in certain burners. For example, it is known in the art that the ash content of a coal and the total amount of sulfur compared to the ratio of iron to calcium and magnesium determines whether a coal is suitable for use in a cyclone furnace. Coals with a high iron ratio are unsuitable for use in these furnaces.

Kober also discloses that low-sulfur and high-sulfur coals are not interchangeable in boilers due to the vastly different chemical characteristics. Specifically, Kober states at col. 2, lines 6-15 in reference to switching from high- to low-sulfur coal sources:

In many cases, these alternate coal supplies are *completely different* from the design coal with regard to ash fusion temperature, ash composition, etc. Substitution of coal with ash characteristics significantly different from those for which a boiler was designed can give rise to problems such as slagging.

(Emphasis supplied.)

The disclosure of Kober reinforces that known in the art: different coals are not interchangeable due to distinct chemistries. Kober thus teaches away from the combination of Hepworth and Kober, because one of skill in the art would not expect the combination to be successful.

*Whether Claims 79, 101, and 123 are patentable under 35 U.S.C. §103(a) based on Hepworth in view of Kober, et al.*

Claims 58, 79, 101, and 123 are directed to the iron-containing additive including a hydrocarbon, oil, grease, and/or xanthan gum.

Neither Hepworth nor Kober, et al., teach or suggest this feature.

*Whether Claims 69, 93, 115 and 139 are patentable under 35 U.S.C. §103(a) based on Benner in view of Hepworth.*

Claims 69, 93, and 139 require the solid fuel to include a coal having a total iron content of less than about 10 wt.% (dry basis of the ash), and wherein the coal has a calcium content of at least about 15 wt.% (dry basis of the ash). Claim 115 requires the solid fuel to have a total iron content of less than about 10 wt.% (dry basis of the ash), and wherein the solid fuel has an alkali content of at least about 20 wt. % (dry basis of the ash)

Neither Kober, et al., nor Hepworth disclose a coal having this composition.

Accordingly, a *prima facie case* of obviousness has not been established. Applicant thus requests that these rejections be withdrawn.

The Board is thus respectfully requested to overturn the rejection.

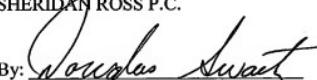
Since the cited references fail to teach or suggest every claimed feature, whether taken alone or in combination, anticipation has not been established - the Board is respectfully requested to overturn the above rejections.

Remand to the Examiner with an indication of allowable subject matter is respectfully requested.

The Commissioner is hereby authorized to charge to deposit account number 19-1970 (4366-94) any fees under 37 CFR § 1.16 and 1.17 that may be required by this paper and to credit any overpayment to that Account. If any extension of time is required in connection with the filing of this paper and has not been separately requested, such extension is hereby petitioned.

Respectfully submitted,  
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(viii) CLAIMS APPENDIX.

1-23. (Canceled)

24. A method of operating a solid fuel fired boiler, comprising:  
introducing a solid fuel into the boiler, wherein the solid fuel is a coal having a sulfur content of less than about 1.5 wt.% (dry basis of the coal);  
introducing an iron-containing material into the boiler, wherein the iron-containing material is at least one of mill scale from steel production and dust from blast furnace gas cleaning equipment; and  
at least partially combusting the solid fuel to produce an ash slag, wherein, in the at least partially combusting step, at least one of the following is true:

- (i) the ash slag has a fluid temperature less than a fluid temperature characteristic of the ash slag produced from combustion of the solid fuel alone; and
- (ii) the ash slag has a melting point less than the melting point of a second ash slag produced from the combustion of the solid fuel alone.

25. The method of claim 24, wherein the ash slag has a viscosity during the at least partially combusting step that is less than the viscosity of the second ash slag produced from combustion of the solid fuel alone.

26. The method of claim 24, wherein the ash slag has a melting point during the at least partially combusting step that is less than the melting point of the second ash slag produced from combustion of the solid fuel alone.

27-32. (Canceled)

33. The method of claim 24, wherein at least a portion of the iron-containing material fluxes the ash slag to produce a second ash slag having at least one characteristic selected from the group consisting of viscosity and melting temperature less than the same characteristic of the second ash slag produced from combustion of the solid fuel alone.

34. The method of claim 25, wherein a  $T_{250}$  temperature at which the ash slag has a viscosity of 250 poise produced from the combustion of the solid fuel and iron-containing material is at least 100 degrees Fahrenheit lower than the  $T_{250}$  temperature of the second ash slag produced from the combustion of the solid fuel alone.

35. (Canceled)

36. The method of claim 24, wherein the melting point of the second ash slag is less than 2600 degrees F.

37-43. (Canceled)

44. The method of claim 24, wherein (i) is true.

45. The method of claim 24, wherein the fluid temperature is less than 2600 degrees F.
46. The method of claim 24, wherein (ii) is true.
47. The method of claim 24, wherein the solid fuel is introduced into a wet-bottom boiler.
48. The method of claim 24, wherein the solid fuel comprises a sub-bituminous coal and wherein the solid fuel has a low iron content and a high alkali content.
49. The method of claim 24, wherein the boiler is for at least one of steam production and electricity generation and wherein the iron-containing material has a P<sub>90</sub> size of no more than about 300 microns.
50. The method of claim 24, wherein the boiler is a cyclone boiler.
51. The method of claim 24, wherein the ash slag has a viscosity such that the ash slag flows from the boiler.
52. The method of claim 50, further comprising reducing the particle size of the solid fuel prior to introducing the solid fuel into the boiler.
53. The method of claim 24, wherein the iron-containing material is mill scale from steel production.
54. The method of claim 24, wherein the iron-containing material is dust from blast furnace gas cleaning equipment.
55. The method of claim 24, wherein the iron-containing material comprises at least one of ferrous oxide and ferric iron oxide.
56. The method of claim 24, wherein the iron-containing material comprises magnetite.
57. The method of claim 24, wherein the iron-containing material comprises at least one carbon compound.
58. The method of claim 24, further comprising introducing at least one carbon compound along with the iron-containing material, the at least one carbon compound being one or more of a hydrocarbon, oil, grease, and xanthan gum.
59. The method of claim 24, wherein the boiler comprises:
  - a particle size reduction device, wherein the solid fuel is fed to the device;
  - a burner;
  - a fuel transfer system communicating with the device and the burner; and
  - a combustion chamber comprising an enclosure at least partially surrounding the burner and further comprising:

introducing the iron-containing material into at least one of the fuel storage bunker, the fuel transfer system, the cyclone burner, and the combustion chamber.

60. The method of claim 50, wherein the cyclone boiler comprises:

a fuel storage bunker;

a cyclone burner;

a fuel transfer system communicating with the fuel storage bunker and the cyclone burner; and

a combustion chamber comprising an enclosure at least partially surrounding the burners.

61. The method of claim 24, wherein the iron-containing material is introduced into the boiler in an amount ranging from about 10 lb/ton of solid fuel to about 50 lb/ton of solid fuel.

62. The method of claim 24, wherein the ash slag has a total iron concentration of at least about 15 weight percent.

63. The method of claim 50, wherein the iron-containing material is added to the solid fuel before introducing the solid fuel and the iron-containing material into the boiler.

64. The method of claim 50, wherein the ash slag has a viscosity in the boiler less than the viscosity in the boiler of a second ash slag produced from the combustion of the solid fuel alone.

65. The method of claim 24, wherein the iron-containing material is selected from the group consisting of ferrous oxide, ferric oxide, ferrous sulfide, ferric sulfide, and combinations thereof.

66. The method of claim 44, wherein both (i) and (ii) are true.

67. (Canceled)

68. A method of operating a solid fuel fired boiler, comprising:

introducing a solid fuel into a wet-bottom boiler, wherein the solid fuel is a low sulfur coal having a sulfur content of less than about 1.5 wt.% (dry basis of the coal);

introducing an iron-containing material into the wet-bottom boiler, wherein the iron-containing material is at least one of mill scale from steel production and dust from blast furnace gas cleaning equipment; and

at least partially combusting the solid fuel to produce an ash slag, wherein at least a portion of the iron-containing material fluxes the ash slag to cause the ash slag to have a melting temperature less than the melting temperature of a second ash slag produced from the combustion of the solid fuel alone.

69. The method of claim 68, wherein the solid fuel comprises a sub-bituminous coal, wherein the coal has a total iron content of less than about 10 wt.% (dry basis of the ash), and wherein the coal has a calcium content of at least about 15 wt.% (dry basis of the ash).

70. The method of claim 68, wherein the boiler is for at least one of steam production and electricity generation and wherein the iron-containing material has a P<sub>90</sub> size of no more than about 300 microns.

71. The method of claim 68, wherein the boiler is a cyclone boiler.

72. The method of claim 68, wherein the ash slag has a viscosity such that the ash slag flows from the wet-bottom boiler.

73. The method of claim 68, further comprising reducing the particle size of the solid fuel prior to introducing the solid fuel into the boiler.

74. The method of claim 68, wherein the iron-containing material is mill scale from steel production.

75. The method of claim 68, wherein the iron-containing material is dust from blast furnace gas cleaning equipment.

76. The method of claim 68, wherein the iron-containing material comprises at least one of ferrous oxide and ferric iron oxide.

77. The method of claim 68, wherein the iron-containing material comprises magnetite.

78. The method of claim 68, wherein the iron-containing material comprises at least one carbon compound.

79. The method of claim 68, further comprising introducing at least one carbon compound along with the iron-containing material, the at least one carbon compound being one or more of a hydrocarbon, oil, grease, and xanthan gum.

80. The method of claim 68, wherein the wet-bottom boiler comprises:  
a particle size reduction device, wherein the solid fuel is fed to the device;  
a burner;  
a fuel transfer system communicating with the device and the burner; and  
a combustion chamber comprising an enclosure at least partially surrounding the burner and further comprising:

introducing the iron-containing material into at least one of the fuel storage bunker, the fuel transfer system, the cyclone burner, and the combustion chamber.

81. The method of claim 71, wherein the cyclone boiler

comprises:

- a fuel storage bunker;
  - a cyclone burner;
  - a fuel transfer system communicating with the fuel storage bunker and the cyclone burner; and
  - a combustion chamber comprising an enclosure at least partially surrounding the burners.
82. The method of claim 68, wherein the iron-containing material is introduced into the boiler in an amount ranging from about 10 lb/ton of solid fuel to about 20 lb/ton of solid fuel.
83. The method of claim 68, wherein the ash slag has a total iron concentration of at least about 15 weight percent.
84. The method of claim 68, wherein the iron-containing material is added to the solid fuel before introducing the solid fuel and the iron-containing material into the boiler.
85. The method of claim 68, wherein the second ash slag has a viscosity in the boiler less than the viscosity in the boiler of the ash slag produced from the combustion of the solid fuel alone.
86. The method of claim 68, wherein the iron-containing material is selected from the group consisting of ferrous oxide, ferric oxide, ferrous sulfide, ferric sulfide, and combinations thereof.
87. The method of claim 68, wherein, in the at least partially combusting step, a fluid temperature of the ash slag is less than the a fluid temperature of a second ash slag produced from combustion of the solid fuel alone.
88. The method of claim 87, wherein the fluid temperature is less than 2600°F.
89. (Canceled)
90. A method of operating a solid fuel fired boiler, comprising:
  - introducing a solid fuel into a wet-bottom boiler, the solid fuel comprising a low sulfur coal having a sulfur content of less than about 1.5 wt.% (dry basis of the coal);
  - introducing an iron-containing material into the wet-bottom boiler, wherein the iron-containing material is at least one of mill scale from steel production and dust from blast furnace gas cleaning equipment; and
  - at least partially combusting the solid fuel to produce an ash slag, wherein at least a portion of the iron-containing material fluxes the ash slag to cause the ash slag to have a

viscosity in the boiler less than the viscosity in the boiler of a second ash slag produced from the combustion of the solid fuel alone.

91. The method of claim 90, wherein the solid fuel comprises a sub-bituminous coal.

92. The method of claim 90, wherein the boiler is for at least one of steam production and electricity generation and wherein the iron-containing material has a P<sub>90</sub> size of no more than about 300 microns.

93. The method of claim 90, wherein the boiler is a cyclone boiler, wherein the low sulfur coal has a total iron content of less than about 10 wt.% (dry basis of the ash), and wherein the low sulfur coal has a calcium content of at least about 15 wt.% (dry basis of the ash).

94. The method of claim 90, wherein the ash slag has a viscosity such that the ash slag flows from the wet-bottom boiler.

95. The method of claim 90, further comprising reducing the particle size of the solid fuel prior to introducing the solid fuel into the boiler.

96. The method of claim 90, wherein the iron-containing material is mill scale from steel production.

97. The method of claim 90, wherein the iron-containing material is dust from blast furnace gas cleaning equipment.

98. The method of claim 90, wherein the iron-containing material comprises at least one of ferrous oxide and ferric iron oxide.

99. The method of claim 90, wherein the iron-containing material comprises magnetite.

100. The method of claim 90, wherein the iron-containing material comprises at least one carbon compound.

101. The method of claim 90, further comprising introducing at least one carbon compound along with the iron-containing material, the at least one carbon compound being one or more of a hydrocarbon, oil, grease, and xanthan gum.

102. The method of claim 90, wherein the wet-bottom boiler comprises:  
a particle size reduction device, wherein the solid fuel is fed to the device;  
a burner;  
a fuel transfer system communicating with the device and the burner; and  
a combustion chamber comprising an enclosure at least partially surrounding the burner and further comprising:

introducing the iron-containing material into at least one of the fuel storage bunker, the fuel transfer system, the cyclone burner, and the combustion chamber.

103. The method of claim 93, wherein the cyclone boiler comprises:

a fuel storage bunker;

a cyclone burner;

a fuel transfer system communicating with the fuel storage bunker and the cyclone burner; and

a combustion chamber comprising an enclosure at least partially surrounding the burners.

104. The method of claim 90, wherein the iron-containing material is introduced into the boiler in an amount ranging from about 10 lb/ton of solid fuel to about 50 lb/ton of solid fuel.

105. The method of claim 90, wherein the ash slag has a total iron concentration of at least about 15 weight percent.

106. The method of claim 90, wherein the iron-containing material is added to the solid fuel before introducing the solid fuel and the iron-containing material into the boiler.

107. The method of claim 90, wherein the ash slag has a melting temperature less than the melting temperature of the second ash slag produced from the combustion of the solid fuel alone.

108. The method of claim 90, wherein the iron-containing material is selected from the group consisting of ferrous oxide, ferric oxide, ferrous sulfide, ferric sulfide, and combinations thereof.

109. The method of claim 90, wherein, in the at least partially combusting step, a fluid temperature of the ash slag is less than a fluid temperature of the second ash slag produced from combustion of the solid fuel alone.

110. The method of claim 109, wherein the fluid temperature is less than 2600°F.

111. (Cancelled)

112. A method of operating a solid fuel fired boiler, comprising:

introducing a solid fuel into a wet-bottom boiler, the solid fuel comprising a low sulfur coal having a sulfur content of less than about 1.5 wt.% (dry basis of the coal);

introducing an iron-containing material into the wet-bottom boiler, wherein the iron-containing material comprises iron oxides; and

at least partially combusting the solid fuel to produce an ash slag, wherein at least a portion of the iron-containing material fluxes the ash slag to cause the ash slag to have a

viscosity less than a viscosity of a second ash slag produced from the combustion of the solid fuel alone.

113. The method of claim 112, wherein the solid fuel comprises a sub-bituminous coal.

114. The method of claim 112, wherein the boiler is for at least one of steam production and electricity generation and wherein the iron-containing material has a P<sub>90</sub> size of no more than about 300 microns.

115. The method of claim 112, wherein the boiler is a cyclone boiler, wherein the solid fuel has a total iron content of less than about 10 wt.% (dry basis of the ash), and wherein the solid fuel has an alkali content of at least about 20 wt. % (dry basis of the ash).

116. The method of claim 112, wherein the ash slag has a viscosity such that the ash slag flows from the wet-bottom boiler.

117. The method of claim 112, further comprising reducing the particle size of the solid fuel prior to introducing the solid fuel into the boiler.

118. The method of claim 112, wherein the iron-containing material is mill scale from steel production.

119. The method of claim 112, wherein the iron-containing material is dust from blast furnace gas cleaning equipment.

120. The method of claim 112, wherein the iron-containing material comprises at least one of ferrous oxide and ferric iron oxide.

121. The method of claim 112, wherein the iron-containing material comprises magnetite.

122. The method of claim 112, wherein the iron-containing material comprises at least one carbon compound.

123. The method of claim 112, further comprising introducing at least one carbon compound along with the iron-containing material, the at least one carbon compound being one or more of a hydrocarbon, oil, grease, and xanthan gum.

124. The method of claim 112, wherein the wet-bottom boiler comprises:  
a particle size reduction device, wherein the solid fuel is fed to the device;  
a burner;  
a fuel transfer system communicating with the device and the burner; and  
a combustion chamber comprising an enclosure at least partially surrounding the burner and further comprising:

introducing the iron-containing material into at least one of the fuel storage bunker, the fuel transfer system, the cyclone burner, and the combustion chamber.

125. The method of claim 115, wherein the cyclone boiler comprises:

- a fuel storage bunker;
- a cyclone burner;
- a fuel transfer system communicating with the fuel storage bunker and the cyclone burner; and
- a combustion chamber comprising an enclosure at least partially surrounding the burners.

126. The method of claim 112, wherein the iron-containing material is introduced into the boiler in an amount ranging from about 10 lb/ton of solid fuel to about 20 lb/ton of solid fuel.

127. The method of claim 112, wherein the ash slag has a total iron concentration of at least about 15 weight percent.

128. The method of claim 112, wherein the iron-containing material is added to the solid fuel before introducing the solid fuel and the iron-containing material into the boiler.

129. The method of claim 112, wherein the ash slag has a melting point in the boiler less than the melting point in the boiler of the second ash slag produced from the combustion of the solid fuel alone.

130. The method of claim 112, wherein the iron-containing material is selected from the group consisting of ferrous oxide, ferric oxide, ferrous sulfide, ferric sulfide, and combinations thereof.

131. The method of claim 112, wherein, in the at least partially combusting step, a fluid temperature of the ash slag is less than the a fluid temperature of the second ash slag produced from combustion of the solid fuel alone.

132. The method of claim 131, wherein the the fluid temperature is less than 2600°F.

133. (Canceled)

134. A method for operating a slag type furnace, comprising:

introducing a coal-containing fuel into said slag type furnace, the coal-containing fuel comprising a low sulfur coal having a sulfur content of less than about 1.5 wt.% (dry basis of the coal);

introducing an iron-containing additive into the slag type furnace in an amount sufficient to flux the coal-containing fuel; and

melting at least a portion of the coal-containing fuel to produce an ash slag, wherein, in the melting step, at least a portion of the iron-containing additive fluxes the ash slag to produce a slag layer having a melting point less than a melting point of a second slag layer without the iron-containing additive.

135. The method of claim 134, wherein at least about 33.5% of the iron-containing additive is in the form of ferrous iron and no more than about 66.5% of the iron in the additive is in the form of ferric iron.

136. The method of claim 134, wherein the additive is in the form of a free-flowing particulate having a P<sub>90</sub> size of no more than about 300 microns.

137. The method of claim 1, wherein the additive comprises one or more of mill scale fines and particles removed by particulate collection systems from one or more of offgases of steel manufacturing and offgases from iron manufacturing, and wherein the coal-containing fuel has a total iron content of less than about 10 wt.% (dry basis of the ash).

138. (Canceled)

139. The method of claim 134, wherein the coal-containing fuel has a total iron content of less than about 10 wt. % (dry basis of the ash) and a calcium content of at least about 15 wt. % (dry basis of the ash).

140. The method of claim 24, wherein the boiler is a slag-tap furnace.

141. The method of claim 24, wherein the solid fuel boiler is used for at least one of steam production and electricity generation.

142. (Canceled)

**(ix) EVIDENCE APPENDIX.**

The following documents are attached:

Exhibit “1” Declaration of Ramon Bisque under 37 C.F.R. §(including attached article “*Steam/its generation and use*”).

Exhibit “2” Article “*Coal Properties, Sampling & Ash Characteristics*”

Exhibit “3” U.S. Patent 6,484,651 to Shepard, Jr., et al.

Exhibit “4” Page attached to Office Action.

Exhibit “5” Page8-9 attached to Babcock & Wilcox, *Steam its generation and use*

**(x) RELATED PROCEEDINGS APPENDIX.**

None.